(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 576 563 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
06.05.1999 Bulletin 1999/18

(21) Application number: **92908704.7**

(22) Date of filing: **19.02.1992**

(51) Int. Cl.^{6}: **A61L 2/00**, B01D 19/00, B01J 19/08, C02F 1/78

(86) International application number:
PCT/US92/01324

(87) International publication number:
WO 92/16241 (01.10.1992 Gazette 1992/25)

(54) **BATCH LIQUID PURIFIER**

VORRICHTUNG ZUR DISKONTINUIERLICHEN REINIGUNG VON FLÜSSIGKEITEN

DISPOSITIF DE PURIFICATION DISCONTINUE DE LIQUIDES

(84) Designated Contracting States:
DE FR GB

(30) Priority: **18.03.1991 US 670690**

(43) Date of publication of application:
05.01.1994 Bulletin 1994/01

(60) Divisional application:
98116913.9 / 0 893 127
98116912.1 / 0 893 126

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Description

[0001] This invention involves ozone purification of batches of liquid with equipment made small enough to operate on a countertop or in space available below a counter.

[0002] By this invention, I have reduced the size, complexity, and expense of equipment for purifying batches of liquid with ozone; and by carefully selecting and combining components, I have been able to make smaller scale ozone purification equipment operate conveniently and reliably for safely purifying liquid batches within reasonably short times. Equipment according to my invention can be operated on a residential countertop or in a small space under a counter, for example, to produce purified liquid batches less than 20 liters in size.

[0003] Demand systems for purification of water by ozone are seen in US-A-4 599 166 which has a supply tank which may be, for example of 20 litres capacity, and in my own earlier US-A-3 823 728.

[0004] The purifier of this invention includes a generator that makes an ozone containing gas and operates on a batch basis with a reservoir or chamber sized for holding less than 20 liters of liquid. By one arrangement, the liquid flows through a passageway from the reservoir to a separate purified liquid container, and a gas passageway from the generator leads ozone to the liquid passageway. A pumping system causes the liquid to flow through the liquid passageway and causes the gas to contact the liquid with ozone to effect its purification as it proceeds toward the purified liquid container. The pumping rate and the dimensions of the liquid and gas passageways determine the flow rates of the liquid and the ozone containing gas. A pumping system can also be arranged for contacting the liquid with ozone containing gas during a purification cycle, and then outputting purified liquid during an output cycle.

DRAWINGS

[0005] All of the drawings are partially schematic diagrams of different preferred embodiments of my batch liquid purifier.

Figure 1 shows an in-line system for pumping liquid from a reservoir to a purified liquid container while contacting the liquid with ozone to ensure its purification; and

Figures 2-4 schematically show three preferred alternatives for pumping systems usable in the embodiment of Figure 1.

DETAILED DESCRIPTION

[0006] The preferred embodiments of the drawings have comparative advantages in features such as convenience, reliability, safety, cost, and compactness. Different embodiments, using different combinations of such features, may be preferred for different users with different desires. The embodiments will be explained in the order presented in the drawings, but this does not imply any similar order of importance. Also, some of the different features that are illustrated in the drawings can be interchanged among the various embodiments, and the drawings are arranged to illustrate the different features that can be combined, and not to delimit one combination of features from another.

[0007] The reasons that the purifier embodiments can be varied so extensively include the many different uses for liquid purifiers and the correspondingly different considerations for expense, space requirements, and batch size. One important use is purifying water for drinking and cooking purposes. This can be done on or below a countertop with batches sized for coffeepots and hand-held pitchers. Different users will require different levels of sophistication in convenience and extent of automatic performance. Water can also be purified on a batch basis for small scale requirements in laboratories, offices, and industries. The liquid to be purified is not necessarily water, and my purifiers can be applied to purifying saline solution, for example. This could be desirable in an optometrist's office, for rinsing and storing contact lenses.

[0008] The liquid purifier 10 of FIG. 1 purifies raw liquid as it flows from reservoir 11 to purified liquid container 12. A pumping system 20 directs the liquid flow from reservoir 11 to container 12 and contacts the liquid with an ozone containing gas from generator 15 so that the liquid is purified as the flow occurs.

[0009] Reservoir 11 and container 12 are sized to hold less than 20 liters of liquid and can be made small enough to hold one coffee pot full of liquid, for example. Reservoir 11 can have a quickly releasable connection 13 that includes a check valve 14 for connecting and disconnecting reservoir 11 with liquid flow line 16 leading to pumping system 20. A gas flow line 17 leads from ozone generator 15, preferably via a check valve 18, to convey a gas and ozone mixture to pumping system 20. Besides conventional check valving, check valve 18 can be formed of a porous hydrophobic material that allows gas to pass through but prevents any liquid backflow from reaching generator 15. This is especially desirable when generator 15 is the preferred corona discharge generator that would be damaged by presence of any liquid. Suitable porous hydrophobic materials can include hydrophobic resin or plastic materials that are made porous to allow passage of gas, but block the passage of liquid. Porous inorganic materials may also be usable for this. The entire material does not need to be hydrophobic, so long as a hydrophobic material is arranged to serve as a liquid barrier combined with an otherwise porous material. These considerations also apply to other uses of porous hydrophobic materials in my purifiers, as explained below.

[0010] Although ambient air is a simple and preferred

input for generator 15, it is also possible to use dried air that has passed through a dryer to help keep moisture out of generator 15. Another possibility is supplying oxygen from a small container serving as the input to generator 15, which can produce more ozone from an oxygen supply than from an air supply.

[0011] Pumping system 20 can take several forms, as explained more fully below. Generally, it draws liquid from reservoir 11 via liquid line 16 and contacts the liquid with ozone contained in a gas drawn via line 17 so that the ozone purifies the liquid before it reaches chamber 12. In the embodiment of FIG. 1, the gas and liquid output from pumping system 20 is directed to a gas and liquid separator 21. The gas drawn from generator 15 and combined with the liquid by pumping system 20 separates from the liquid in separator 21 and is vented to atmosphere. This preferably occurs through an ozone reducer 23 that reduces the concentration of ozone in any gas entering the atmosphere. Reducer 23 contains at least one of several materials that are available for reducing the ozone concentration or changing the ozone into ordinary oxygen so that raw ozone does not escape into the atmosphere. Even if raw ozone were to escape through vent 22, however, it should not present any health hazard in the small quantities used for operating system 10.

[0012] There are several ways that gas and liquid separator 21 can operate. The liquid level is preferably controlled by a float valve, which has the advantage of keeping the liquid pressurized. Gravity can also be used to provide a liquid surface above which gas can rise. Another possibility is to arrange a porous hydrophobic element to form a barrier for liquid, while allowing gas to pass. The liquid and gas separation can occur separate from a liquid reservoir or purified liquid storage, or can be combined with these, as explained below.

[0013] When reducer 23 is used and is filled with a catalytic or reactive material that reduces the ozone concentration or changes the ozone into oxygen, it is important that liquid not reach the material within reducer 23, because liquid would impair its action. Working against this is the fact that gas bubbles enter separator 21 and burst at the liquid surface there, creating spray droplets that can enter vent 22. Baffles are one possibility for keeping these spray droplets out of reducer 23, but baffles would not block liquid flow if the system were overturned. What I prefer, therefore, is a porous hydrophobic element 24 that allows gas, but not liquid, to enter reducer 23.

[0014] From gas and liquid separator 21, liquid proceeds to purified liquid container 12. In doing so, purified liquid can flow past sensor 25, to detect the concentration of dissolved ozone in the liquid to verify that the liquid is adequately purified. Sensor 25 is preferably in communication with control system 30, which operates pumping system 20 and ozone generator 15. Control system 30 preferably includes a timer for timing each operation of system 10. An ozone sensor can also be arranged in this and other embodiments of my purifiers to ensure that purified liquid output does not contain more than a minimum of dissolved ozone. A timer can also be involved with control system 30 to ensure adequate de-ozonization of purified liquid output. Ozone sensors and timers for this purpose are preferably arranged in communication with the purified liquid storage or purified liquid output flow.

[0015] The flow of purified liquid into chamber 12 can also pass through filter 26, which can contain activated carbon or a catalyst that greatly reduces the concentration of dissolved ozone remaining in the purified liquid. This can be advantageous in situations requiring that little or no dissolved ozone remain in the liquid that is output from chamber 12. Other ways of ensuring this are to let the purified liquid stand for a few minutes in chamber 12 before using it, to aerate the purified liquid before using it, or to subject the purified liquid to ultraviolet light. By whatever method is used, the dissolved ozone concentration should be reduced before the purified liquid is output for use or consumption. For most purposes, dissolved ozone is acceptable in the purified liquid; and no health hazard has yet been identified with directly consuming water containing dissolved ozone at levels found in system 10.

[0016] Control system 30 also preferably includes a switch that initiates operation of system 10. This can run pumping system 20 and ozone generator 15 for long enough to empty reservoir 11 and transfer purified liquid to chamber 12. Sensor 25 can verify from the presence of dissolved ozone in the passing liquid that ozone generator 15 is operating and delivering ozone to the moving liquid. If sensor 25 does not detect ozone in the liquid, a warning or indicator light could be illuminated to inform the operator, or control system 30 could shut down pumping system 20 and generator 15.

[0017] Several alternative pumping systems 20, suitable for use in system 10 of FIG. 1, are shown in FIGS. 2-4. These pumping systems can also be used in other preferred embodiments of my liquid purifier. The flow rates of liquid and gas through any pumping system used with my liquid purifier are preferably adjusted by sizing the liquid and gas conduits relative to the pumping rate and the force causing flow to occur. This eliminates the expense of detecting and metering flow rates to ensure adequate contact of liquid with ozone. The time that liquid and ozone are in contact with each other is also a factor in the purification process, since purification is a function of both the extent and the duration of ozone contact with liquid. Thus, pumping systems and liquid and gas flow lines should be selected to ensure proper flow rates of liquid and gas and adequate contact times between liquid and the ozone contained in the gas.

[0018] The pump 27 of FIG. 2 is preferably a positive displacement pump that receives the combined flows of liquid in line 16 and an ozone containing gas in line 17. Pump 27 then mixes and contacts the gas and liquid so

that within pump 27 and downstream of pump 27, the liquid is in purifying contact with ozone. I have found that positive displacement pumps are good at mixing liquid and gas for contact purposes, but other types of pumps can also be used. Moreover, it is possible to use a static mixer 28 downstream of pump 27, to increase the mixing action.

[0019] Pump 31 of the embodiment of FIG. 3 is also a liquid pump and can move liquid by positive displacement or by some other pumping means. Downstream of pump 31 is a venturi 32 that draws in an ozone containing gas from line 17 to mix with and contact the liquid flowing from pump 31.

[0020] Pump 33, of the embodiment of FIG. 4, is a gas pump that forces the ozone containing gas through line 17 into chamber 34 from which a bubble line 35 extends. Gas bubbles rising in chamber 34 not only contact liquid present there, but also pump the liquid through bubble line 35 as the bubbles rise. This moves the gas and liquid mixture downstream toward gas and liquid separator 21 (not shown in FIG. 4).

[0021] Gas pump 33 is preferably arranged upstream of generator 15 so that it can force gas through generator 15, which outputs a mixture of gas and ozone. Pump 33 can also be arranged downstream of ozone generator 15, except that an ozone environment is too corrosive and problematic for most pumps to handle. Although pumping system 20 is shown in FIGS. 1 and 5-9 as downstream of generator 15, when a pumping arrangement such as shown in FIG. 4 is used for a pumping system 20, gas pump 33 is preferably arranged upstream of generator 15.

Claims

1. A batch operation purifier (10) using a generator (15) that makes an ozone containing gas, said purifier comprising:

    a. a reservoir (11) sized for holding less than 20 liters of a liquid;
    b. a liquid passageway (16) arranged for conducting said liquid from said reservoir to a separate purified liquid container (12) also sized for holding less than 20 liters;
    c. a gas passageway (17) leading from said generator to said liquid passageway;
    d. a pumping system (20) arranged for causing said liquid to flow through said liquid passageway and for contacting said liquid with said ozone containing gas to effect purification of said liquid; and
    e. said pumping system (20) and said liquid and gas passageways (16,17) being sized to determine the flow rates of said liquid and said ozone containing gas.

2. The purifier of claim 1 wherein said gas passageway is connected to said liquid passageway upstream of an inlet to a pump so that said pump (20) contacts said ozone containing gas with said liquid by mixing and pumps the mixture of said liquid and said ozone containing gas through said liquid passageway.

3. The purifier of claim 1 or claim 2 wherein the liquid passageway includes a gas liquid separator (21) for separating ozone from the purified liquid.

4. The purifier of claim 1, claim 2 or claim 3 including means (23) for reducing the concentration of any ozone escaping into the atmosphere and means (21,24) for preventing flow of liquid into said reducer.

5. The purifier of claim 4 wherein a said means for preventing flow (24) is a porous element including a hydrophobic material.

6. The purifier of any one of the preceding claims wherein the liquid passageway includes a filter (26) containing activated carbon or a catalyst for reducing the concentration of remanent ozone.

7. The purifier of any one of the preceding claims wherein the reservoir (11) has a releasable connector (13) including a check valve (14) for connecting the reservoir to or disconnecting it from the liquid passageway (16).

Patentansprüche

1. Reinigungsvorrichtung (10) für den Chargenbetrieb unter Verwendung eines Generators (15), der ein ozonhältiges Gas erzeugt, wobei die Reinigungsvorrichtung umfaßt:

    a) ein Reservoir (11) in einer solchen Größe, daß es weniger als 20 l einer Flüssigkeit faßt;
    b) einen Flüssigkeitskanal (16), der so angeordnet ist, daß er die Flüssigkeit aus dem Reservoir zu einem getrennten Behälter (12) für gereinigte Flüssigkeit leitet, der ebenfalls eine solche Größe aufweist, daß er weniger als 20 l faßt;
    c) einen Gaskanal (17), der vom Generator zum Flüssigkeitskanal führt;
    d) ein Pumpsystem (20), das so angeordnet ist, daß es bewirkt, daß Flüssigkeit durch den Flüssigkeitskanal fließt und daß die Flüssigkeit mit dem ozonhältigen Gas in Kontakt kommt, wodurch Reinigung der Flüssigkeit bewirkt wird; und
    e) wobei das Pumpsystem (20) und der Flüssigkeits- und der Gaskanal (16, 17) eine solche Größe haben, daß sie die Strömungsraten der

Flüssigkeit und das ozonhältigen Gases bestimmen.

2. Reinigungsvorrichtung nach Anspruch 1, worin der Gaskanal stromauf vom Einlaß zu einer Pumpe an den Flüssigkeitskanal angeschlossen ist, so daß die Pumpe (20) das ozonhältige Gas durch Mischen mit der Flüssigkeit in Kontakt bringt und das Gemisch aus der Flüssigkeit und dem ozonhältigen Gas durch den Flüssigkeitskanal pumpt.

3. Reinigungsvorrichtung nach Anspruch 1 oder 2, worin der Flüssigkeitskanal einen Gas-Flüssigkeits-Abscheider (21) zum Abtrennen von Ozon von der gereinigten Flüssigkeit umfaßt.

4. Reinigungsvorrichtung nach Anspruch 1, 2 oder 3, die Mittel (23) zum Reduzieren der Konzentration von etwaigem in die Atmosphäre entweichendem Ozon und Mittel (21, 24) zur Verhinderung des Strömens von Flüssigkeit in die Reduziervorrichtung umfaßt.

5. Reinigungsvorrichtung nach Anspruch 4, worin ein Mittel zur Verhinderung von Strömung (24) ein poröses Element ist, das ein hydrophobes Material umfaßt.

6. Reinigungsvorrichtung nach einem der vorangegangenen Ansprüche, worin der Flüssigkeitskanal einen Filter (26) umfaßt, der Aktivkohle oder einen Katalysator zum Reduzieren der Konzentration an verbleibendem Ozon enthält.

7. Reinigungsvorrichtung nach einem der vorangegangenen Ansprüche, worin das Reservoir (11) einen lösbaren Verbinder (13) aufweist, der ein Rückschlagventil (14) zum Verbinden des Reservoirs mit dem oder Abtrennen vom Flüssigkeitskanal (16) umfaßt.

Revendications

1. Purificateur à fonctionnement discontinu (10) utilisant un générateur (15) qui fabrique un gaz contenant de l'ozone, ledit purificateur comprenant :

   a. un réservoir (11) dimensionné pour contenir moins de 20 litres d'un liquide;
   b. un passage de liquide (16) agencé pour conduire ledit liquide dudit réservoir à un récipient de liquide purifié séparé (12) également dimensionné pour contenir moins de 20 litres;
   c. un passage de gaz (17) conduisant dudit générateur audit passage de liquide;
   d. un système de pompage (20) agencé pour amener ledit liquide à s'écouler à travers ledit passage du liquide et pour mettre en contact ledit liquide avec ledit gaz contenant de l'ozone pour effectuer une purification dudit liquide; et
   e. ledit système de pompage (20) et lesdits passages de liquide de gaz (16, 17) étant dimensionnés pour déterminer les débits dudit liquide et dudit gaz contenant de l'ozone.

2. Purificateur de la revendication 1, dans lequel le passage de gaz précité est relié au passage de liquide précité en amont d'une entrée à une pompe de sorte que la pompe (20) précitée contacte le gaz contenant de l'ozone précité avec le liquide précité par mélange et pompe le mélange dudit liquide et dudit gaz contenant de l'ozone à travers ledit passage de liquide.

3. Purificateur de la revendication 1 ou de la revendication 2 dans lequel le passage de liquide comprend un séparateur de liquide gaz (21) pour séparer de l'ozone du liquide purifié.

4. Purificateur de la revendication 1, de la revendication 2 ou de la revendication 3 comprenant un moyen (23) pour réduire la concentration de tout ozone s'échappant à l'atmosphère et un moyen (21, 24) pour empêcher l'écoulement de liquide dans ledit réducteur.

5. Purificateur de la revendication 4 dans lequel le moyen (24) précité pour empêcher l'écoulement est un élément poreux comprenant un matériau hydrofuge.

6. Purificateur de l'une quelconque des revendications précédentes dans lequel le passage du liquide comprend un filtre (26) contenant du charbon activé ou un catalyseur pour réduire la concentration d'ozone restante.

7. Purificateur de l'une quelconque des revendications précédentes, dans lequel le réservoir (11) a un connecteur détachable (13) comprenant un clapet de retenue (14) pour relier le résevoir au passage de liquide (16) ou le déconnecter de celui-ci.

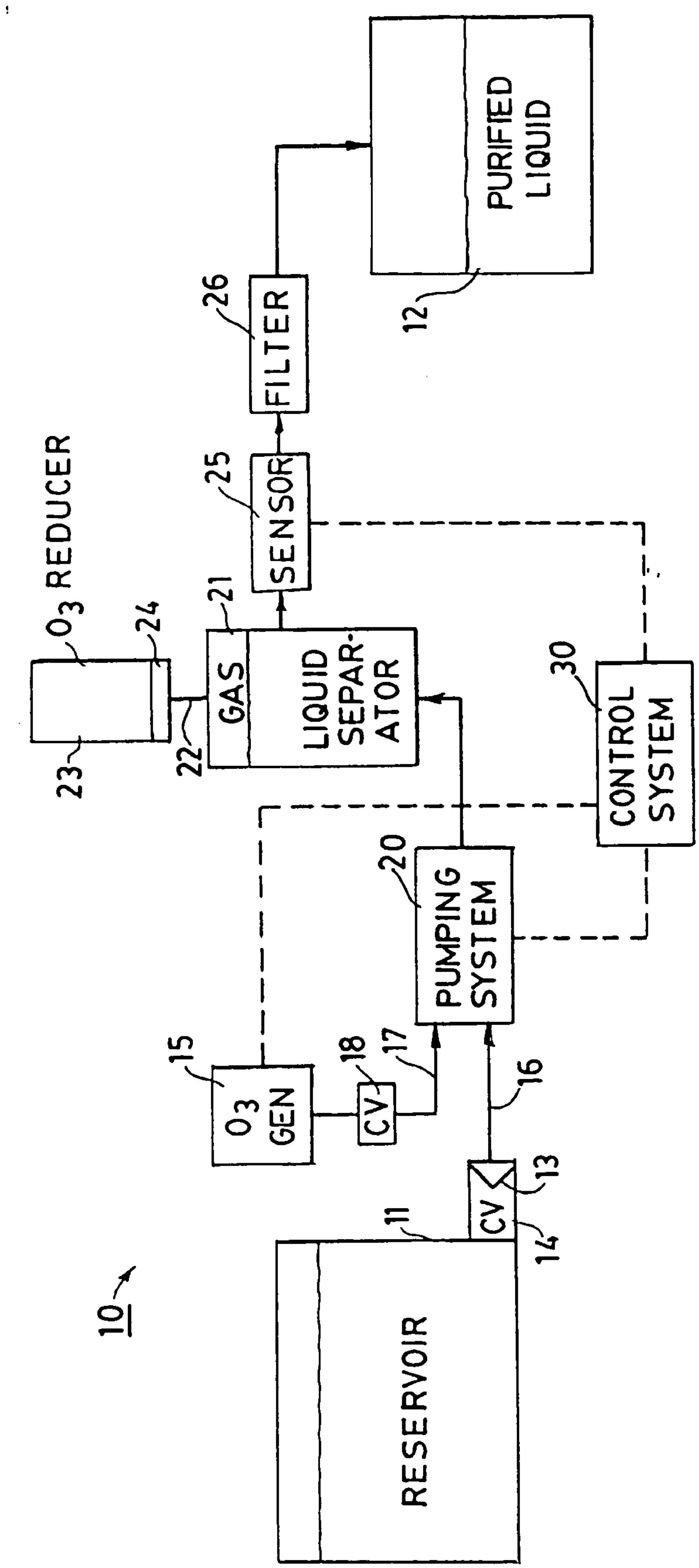
10
RESERVOIR
11
CV
14
13
O_3 GEN
15
CV
18
17
16
PUMPING SYSTEM
20
CONTROL SYSTEM
30
GAS
LIQUID SEPAR-ATOR
21
22
23
24
O_3 REDUCER
SENSOR
25
FILTER
26
PURIFIED LIQUID
12

FIG. 1

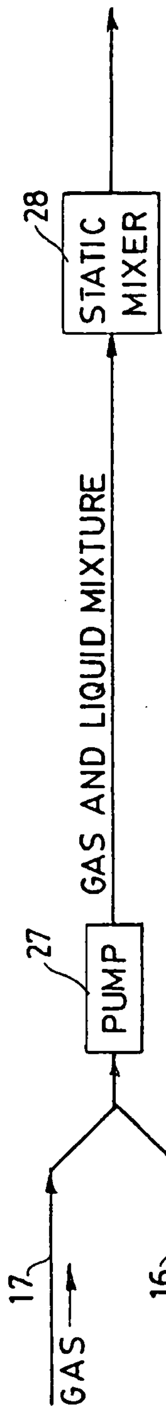

FIG. 2

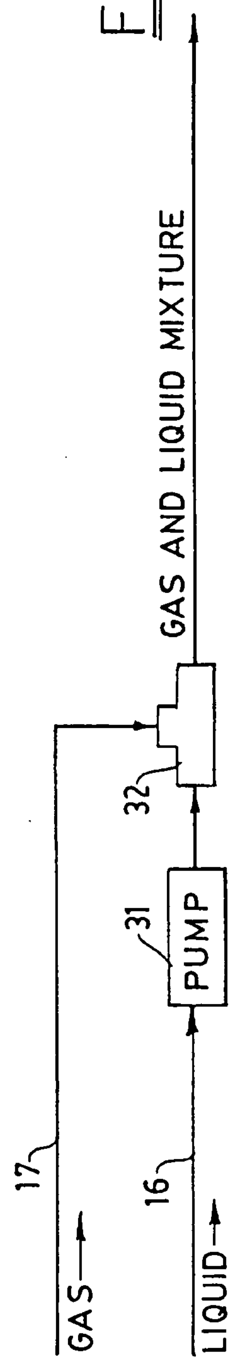

FIG. 3

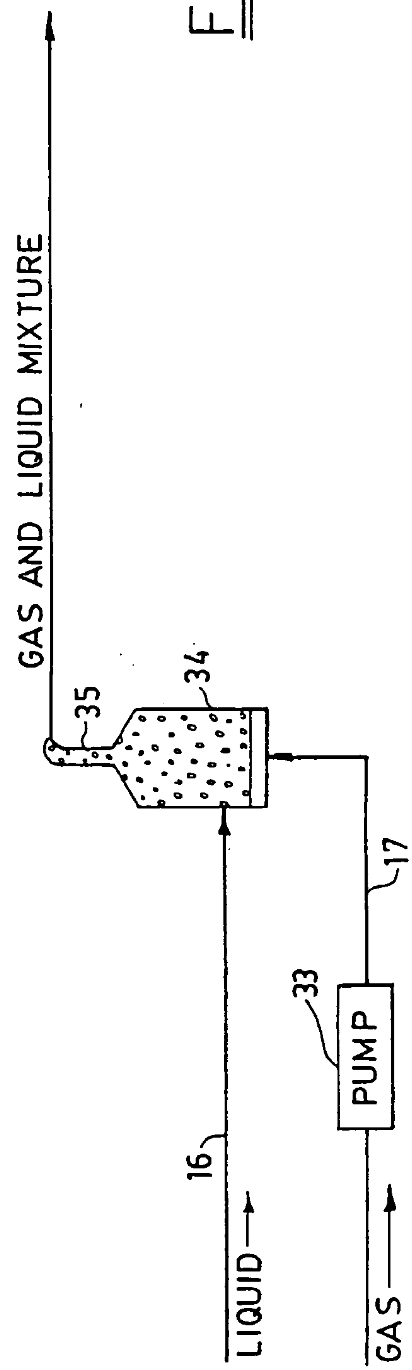

FIG. 4